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OFF-STREAM HYDROPOWER POTENTIAL
IN THE
YELLOWSTONE RIVER BASIN

A
Legislative Summary

March 1983

Prepared for the
Department of Natural Resources and Conservation

By
MORRISON-MAIERLE, INC.
Consulting Engineers

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TABLE OF CONTENTS

Page

SUMMARY v

CHAPTER I. BACKGROUND 1

CHAPTER II. THE OFF-STREAM HYDROPOWER INVESTIGATION PROCESS. . . 3

Inventory of Sites 3
Site Investigation 6
Initial Screening 6
Final Screening. 8
Selection Conclusions. 12

CHAPTER III. THE LOWER DEER CREEK PROJECT 17

Project Concept and Description. 17
Preliminary Environmental Assessment 23
Permitting and Licensing Requirements. 27
Hydropower Marketing Alternatives. 28
Preliminary Economic Analysis. 30

CHAPTER IV. SUPPLEMENTAL INVESTIGATION OF THE STARVED TO DEATH CREEK SITE 36

CHAPTER V. CONCLUSIONS. 41

APPENDIX A. ENABLING LEGISLATION (House Bill 861). 44

APPENDIX B. PHYSICAL CHARACTERISTICS OF THE SIX POTENTIAL DEMONSTRATION SITES. 46

LIST OF TABLES

Page

TABLE 1 INVENTORY OF POTENTIAL OFF-STREAM HYDROPOWER SITES. . . 4
TABLE 2 INVESTIGATION OF THIRTY SITES 7
TABLE 3 EVALUATION OF SIXTEEN SITES 9
TABLE 4 PROJECT SELECTION 11
TABLE 5 DATA SUMMARY – LOWER DEER CREEK PROJECT 19
TABLE 6 CAPITAL COSTS – LOWER DEER CREEK PROJECT. 32
TABLE 7 PRESENT WORTH ANALYSIS – LOWER DEER CREEK PROJECT . . . 33
TABLE 8 CAPITAL COSTS – STARVED TO DEATH CREEK PROJECT. 38
TABLE 9 PRESENT WORTH ANALYSIS – STARVED TO-DEATH CREEK PROJECT 39

LIST OF FIGURES

FIGURE 1 INVENTORY OF SITES. 5
FIGURE 2 PROJECTS FOR ADDITIONAL EVALUATION. 10
FIGURE 3 DEMONSTRATION PROJECT – LOWER DEER CREEK. 18
FIGURE 4 PRESENT WORTH ANALYSIS – LOWER DEER CREEK PROJECT . . . 34
FIGURE 5 PRESENT WORTH ANALYSIS – STARVED TO DEATH CREEK PROJECT 40

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SUMMARY

In response to House Bill 861, passed by the 47th Montana Legislature in 1981, the Department of Natural Resources and Conservation contracted Morrison-Maierle, Inc., consulting engineers, to conduct a reconnaissance-level investigation of potential off-stream hydropower sites in the Yellowstone River Basin and to select one of these sites for a preliminary engineering design and feasibility analysis. After selecting thirty potential sites for off-stream hydropower generation, the list of potential sites was narrowed to a group of sixteen that were deemed suitable for more intensive evaluation. From this group, six sites thought to be the most suitable for possible selection as a feasibility study project were selected. A comparative reevaluation of these six sites indicated that a site on Lower Deer Creek exhibited the most favorable characteristics for demonstrating the feasibility of off-stream hydropower generation in the Yellowstone River Basin.

To evaluate the feasibility of generating hydropower at the Lower Deer Creek site, a hydropower project with two alternative generating capacities--49 megawatt or 60 megawatts--was investigated. Major features of this project would include: a diversion structure on the Yellowstone River near Springdale; a 35.7-mile-long concrete-lined canal to convey diverted water by gravity from the Yellowstone River to the project's storage reservoir; a storage reservoir in the Lower Deer Creek drainage near Greycliff; and two hydroelectric generation facilities--one at the proposed dam and another along the outflow of the dam--that will produce energy as the water returns to the Yellowstone River. A second diversion facility would transfer excess Boulder River flows into the Lower Deer Creek canal to supplement flows from the Yellowstone River.

As designed, the project would use only those river flows in excess of prior water rights and existing water reservations. In an average year, the project would divert 499,000 acre-feet of water from the Yellowstone River and another 100,000 acre-feet from the Boulder River. Instream flow levels, set by the Board of Natural Resources and Conservation, would be

maintained in the affected reaches of the Yellowstone and Boulder rivers whenever the project was in operation. If river flows dropped below set instream flow levels, project diversions would cease.

Results of the studies conducted on the Lower Deer Creek site indicate that hydropower development at the site is not economically feasible. Although the study showed that a 49-megawatt power plant at the site would yield higher project revenues than a 60-megawatt plant, even this alternative would yield a loss of nearly $170 million over the expected 50-year economic life of the project.

A supplemental study of the Starved to Death Creek site, performed to determine whether a project with a larger storage reservoir and the ability to produce peaking power would offer an improved economic picture, also yielded negative results. A preliminary economic analysis of this project site indicated that hydropower development at the site is not economically feasible. Even the most promising generator capacity alternative would yield a net loss of nearly $435.5 million in 1982 dollars at the end of its expected 50-year economic life.

It is important to note that the only economic benefit considered in these analyses was hydropower. Other benefits resulting from a multipurpose project might improve the economic outlook for these projects. However, identifying and assessing benefits other than hydropower revenues was beyond the scope of this study.

CHAPTER I
BACKGROUND

In 1981 the 47th Montana Legislature passed House Bill 861 directing the Montana Department of Natural Resources and Conservation (DNRC) to evaluate the potential for developing off-stream hydropower generation in the Yellowstone River Basin (see Appendix A). Specifically, House Bill 861 directed DNRC to :

> --"Demonstrate that the drainage system of the Yellowstone River can develop substantial supplies of clean hydroelectric power without disrupting the agricultural and other values associated with a free-flowing mainstem of the river;"
>
> --"Demonstrate that off-stream hydroelectric capacity could be investigated within the framework of existing environmental protection statutes and could be implemented within the framework of and to the benefit of existing water rights and reservations;" and
>
> --"Direct consideration of, but not to decide at this time, how electricity so generated could be marketed."

In August 1981, DNRC contracted Morrison-Maierle, Inc., consulting engineers, to conduct a reconnaissance-level investigation of potential off-stream hydropower generation sites in the Yellowstone River Basin and to select one site for preliminary engineering design studies, as directed by House Bill 861. The ensuing investigations, which are summarized in this report, produced four volumes of data, documentation, analysis, and findings:

Volume I – Inventory and Selection of 16 Sites

Volume II – Evaluation of 16 Sites and Selection of Demonstration Project

Volume III – Supplementary Evaluation – Starved to Death Creek Project

Volume IV – Preliminary Design Report – Lower Deer Creek Project

CHAPTER II

THE OFF-STREAM HYDROPOWER INVESTIGATION PROCESS

The investigations conducted in response to House Bill 861 included:

1) an inventory of potential off-stream hydropower generation sites in the Yellowstone River Basin;
2) a determination of the basic engineering factors influencing hydropower production costs at each site;
3) the application of screening criteria to select a project for a feasibility study; and
4) a preliminary engineering design and feasibility analysis of the selected project.

INVENTORY OF SITES

Thirty potential off-stream hydropower generation sites were identified in the reconnaissance studies. These sites, shown in Table 1 and on Figure 1, were selected either because previous investigations had indicated that they exhibited water storage potential or because the physical characteristics of the sites, as shown on USGS topographic maps, indicated that hydropower generation at these sites might be possible. Included were all sites at which hydropower facilities could be built without encountering obvious construction constraints. As stated in House Bill 861, these sites also were selected with the stipulation that:

1) project diversions are limited to excess flows;
2) conveyance to hydropower sites is by gravity;
3) hydropower generation is accomplished at off-stream sites removed from the mainstem river;
4) water used for off-stream hydropower generation is returned to the river.

TABLE 1

INVENTORY OF POTENTIAL OFF-STREAM HYDROPOWER SITES

YELLOWSTONE RIVER BASIN

RIVER SEGMENT **1**	RIVER SEGMENT **2**	RIVER SEGMENT **3**	RIVER SEGMENT **4**
Corwin Springs to Livingston	Livingston to Billings	Billings to Miles City	Miles City to Sidney
CHICORY DROP	BIG TIMBER CREEK	BUFFALO CREEK	SUNDAY CREEK
PRAY SIDING DROP	OTTER CREEK	TULLOCK CREEK	O'FALLON CREEK
TRAIL CREEK	UPPER DEER CREEK	FROZE TO DEATH CR	THIRTEENMILE CREEK
PARK-BRANCH CANAL DROP	LOWER DEER CREEK	STARVED TO DEATH CR	FIRST HAY CREEK
CANYON MOUNTAIN DROP	SWEET GRASS CREEK	BIG PORCUPINE CR	FOX CREEK
	BRIDGER CREEK	SWEENEY CREEK	DEER CREEK
	KEYSER CREEK	MOON CREEK	
	VALLEY CREEK	LIGNITE CREEK	
	LAKE BASIN-MOLT DAM	COAL CREEK	
	CALAMITY JANE		

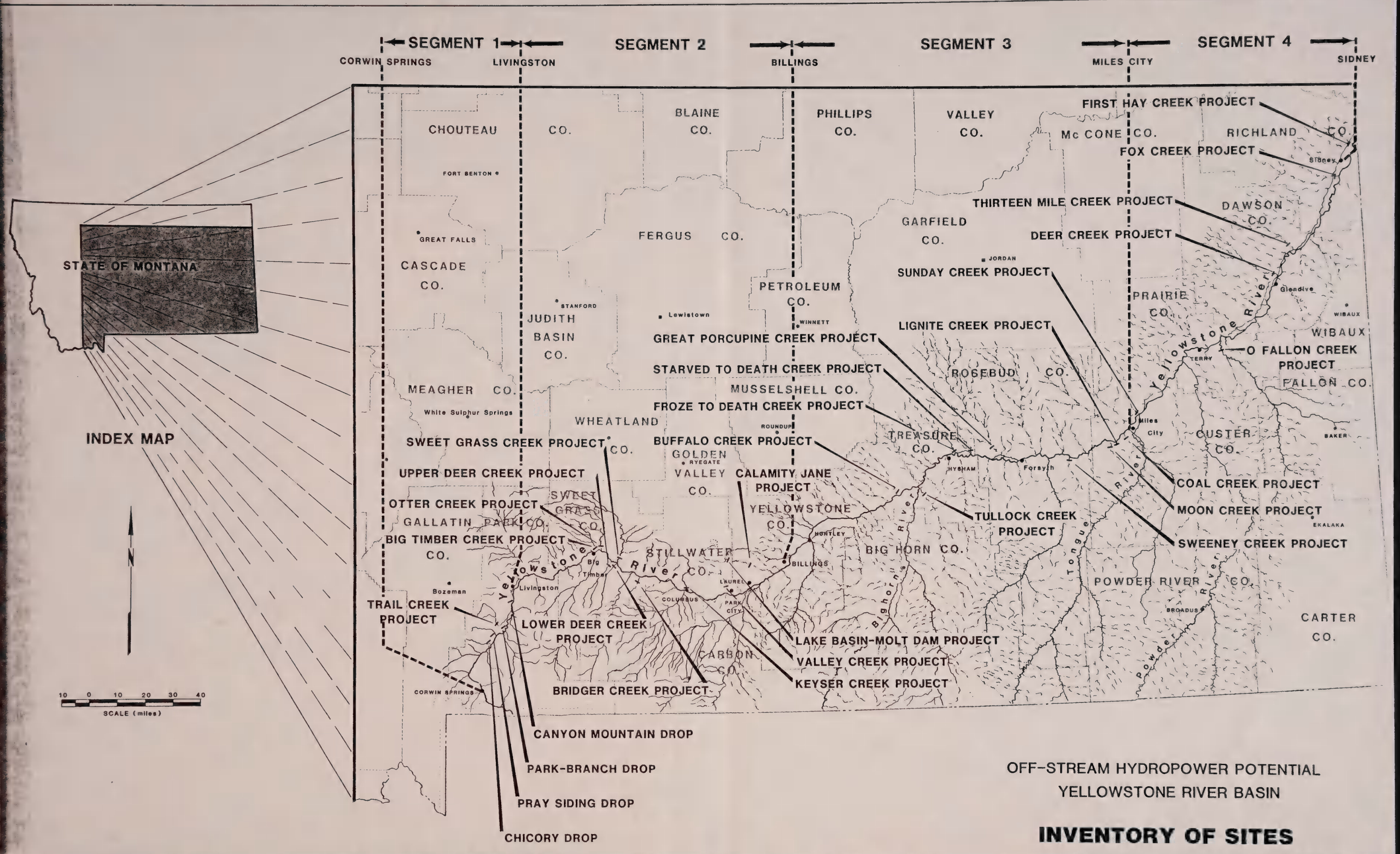
Also considered in the reconnaissance-level inventory were the minimum instream flow requirements set forth by the Montana Board of Natural Resources and Conservation in its 1978 order establishing water reservations for the Yellowstone River. The potential off-stream hydropower sites shown in Table 1 are organized to correspond to the reaches of the Yellowstone River described in that board order. As a part of the board's order, minimum instream flow requirements were assigned for the Yellowstone River and its tributaries. These minimum streamflow amounts, as well as the amounts of water reserved for future consumptive uses, were considered to be unavailable for hydropower production.

TABLE 1

INVENTORY OF POTENTIAL OFF-STREAM HYDROPOWER SITES
YELLOWSTONE RIVER BASIN

RIVER SEGMENT **1**	RIVER SEGMENT **2**	RIVER SEGMENT **3**	RIVER SEGMENT **4**
Corwin Springs to Livingston	Livingston to Billings	Billings to Miles City	Miles City to Sidney
CHICORY DROP PRAY SIDING DROP TRAIL CREEK PARK-BRANCH CANAL DROP CANYON MOUNTAIN DROP	BIG TIMBER CREEK OTTER CREEK UPPER DEER CREEK LOWER DEER CREEK SWEET GRASS CREEK BRIDGER CREEK KEYSER CREEK VALLEY CREEK LAKE BASIN-MOLT DAM CALAMITY JANE	BUFFALO CREEK TULLOCK CREEK FROZE TO DEATH CR STARVED TO DEATH CR BIG PORCUPINE CR SWEENEY CREEK MOON CREEK LIGNITE CREEK COAL CREEK	SUNDAY CREEK O'FALLON CREEK THIRTEENMILE CREEK FIRST HAY CREEK FOX CREEK DEER CREEK

Also considered in the reconnaissance-level inventory were the minimum instream flow requirements set forth by the Montana Board of Natural Resources and Conservation in its 1978 order establishing water reservations for the Yellowstone River. The potential off-stream hydropower sites shown in Table 1 are organized to correspond to the reaches of the Yellowstone River described in that board order. As a part of the board's order, minimum instream flow requirements were assigned for the Yellowstone River and its tributaries. These minimum streamflow amounts, as well as the amounts of water reserved for future consumptive uses, were considered to be unavailable for hydropower production.



OFF-STREAM HYDROPOWER POTENTIAL
YELLOWSTONE RIVER BASIN

INVENTORY OF SITES

SITE INVESTIGATION

Each of the 30 potential off-stream hydropower sites identified through the inventory process was subjected to a reconnaissance-level engineering investigation. These investigations, which included an estimate of the costs for the major project components at the different sites, allowed the preparation of comparative cost estimates for the sites. The results of the engineering investigations are summarized in Table 2, which also shows comparative annual costs per kilowatt hour ($/kWh) for each project.

INITIAL SCREENING

The reconnaissance-level engineering investigations provided a factual basis for applying screening criteria. These criteria were used to determine the relative suitability of each site for hydropower generation and to select a single site for a feasibility study. A major criterion used in the initial screening was the relative cost per kilowatt hour of the hydroelectric power produced. Other criteria used included initial construction costs, reservoir storage capacities, and the number of projects in each river segment. Applying the initial screening criteria resulted in the identification of 16 sites (shown in bold face type on Table 2) that were determined to be suitable for more intensive evaluation.

The 16 sites identified in the initial screening process were further evaluated by assessing the potential environmental impacts of site development on fish and wildlife resources in and adjacent to the Yellowstone River, and by further analyzing off-stream reservoir storage capacities.

This second reconnaissance screening reduced the 16 potential sites to a total of six. These sites (listed in bold face type in Table 3 and shown on Figure 2) were determined to be the sites most suitable for detailed study and possible selection for a feasibility study, based on the criteria used.

TABLE 2

INVESTIGATION OF THIRTY SITES
YELLOWSTONE RIVER BASIN

PROJECT NAME	RIVER SEGMENT	CONSTRUCTION COST ($1,000,000) (1)	ANNUAL REPAYMENT COST ($1,000,000) (2)	ANNUAL HYDROPOWER PRODUCTION ($1,000,000/ KWH) (3)	ANNUAL COST PER KILOWATT HOUR, ($/KWH) (4)
PARK-BRANCH CANAL DROP	**1**	**62**	**4.73**	**92**	**0.051**
CANYON MOUNTAIN DROP	**1**	**28**	**2.15**	**36**	**0.060**
UPPER DEER CREEK	2	114	8.63	137	0.063
PRAY SIDING DROP	**1**	**44**	**3.38**	**52**	**0.064**
LOWER DEER CREEK	**2**	**124**	**9.43**	**147**	**0.064**
CALAMITY JANE	**2**	**182**	**13.82**	**191**	**0.072**
TRAIL CREEK	**1**	**310**	**23.55**	**320**	**0.074**
FIRST HAY CREEK	**4**	**46**	**3.46**	**46**	**0.075**
BRIDGER CREEK	**2**	**219**	**16.63**	**210**	**0.079**
FOX CREEK	**4**	**46**	**3.48**	**40**	**0.087**
VALLEY CREEK	**2**	**113**	**8.59**	**99**	**0.087**
CHICORY DROP	1	85	6.42	71	0.090
SWEENEY CREEK	**3**	**241**	**18.32**	**162**	**0.113**
SUNDAY CREEK	**4**	**238**	**18.08**	**151**	**0.120**
STARVED TO DEATH CREEK	**3**	**75**	**5.73**	**46**	**0.124**
DEER CREEK	**4**	**145**	**11.03**	**81**	**0.136**
O'FALLON CREEK	4	395	29.98	219	0.137
KEYSER CREEK	2	144	10.90	77	0.142
MOON CREEK	**3**	**306**	**23.27**	**162**	**0.144**
BIG TIMBER CREEK	2	137	10.38	71	0.146
SWEET GRASS CREEK	2	99	7.49	49	0.150
THIRTEENMILE CREEK	4	219	16.62	105	0.158
FROZE TO DEATH CREEK	**3**	**73**	**5.91**	**37**	**0.160**
LIGNITE CREEK	3	304	23.08	143	0.161
OTTER CREEK	2	142	10.82	67	0.161
TULLOCK CREEK	3	170	12.90	74	0.175
BUFFALO CREEK	3	165	12.51	61	0.205
COAL CREEK	3	300	22.76	89	0.255
GREAT PORCUPINE CREEK	3	232	17.63	66	0.267
LAKE BASIN - MOLT DAM	2	371	28.20	96	0.293

Bold type denotes sixteen selected projects

(1) Includes all capital costs inventoried in Volumes I and II.

(2) Amortized cost over 50-year project life at Water Resource Council Discount Rate of 7-3/8%.

(3) Based upon 82% efficiency, site specific normal operating need, and use of available excess water at diversion.

(4) Annual Repayment Cost divided by Annual Hydropower Production.

It is important to note that the goal of the screening process was to select the site most suitable for use as a feasibility study project. The results of the process do not mean that sites not selected for feasibility study do not have hydropower generating potential.

FINAL SCREENING

The six potential off-stream hydropower sites – Park-Branch Canal Drop, Canyon Mountain Drop, Lower Deer Creek, First Hay Creek, Valley Creek, and Starved to Death Creek – were selected on the basis of reconnaissance-level engineering evaluations. Selection of a single feasibility study project from these sites was based on more intensive engineering investigations and a reevaluation of each of the six sites. The reevaluations included field investigations of the diversion points, conveyance routes, major crossings, dam and reservoir sites, and reversion routes. Field investigations were performed by an interdisciplinary team comprised of hydrologists, engineers, geologists, and biologists. The field investigations and more intensive analyses assessed geologic conditions, potential sources of dam materials, route locations, and environmental factors.

Field investigations were followed by a detailed computer modeling analysis of development alternatives for each of the six sites.

Variables used in the computer modeling analysis included the following:

-- water supplies available at each diversion point on the Yellowstone River at the 1975 level of depletions, plus future water reservations, including instream reservations under the 1978 Board of Natural Resources and Conservation order;

-- diversion and conveyance facilities ranging in hydraulic capacity from 2,000 to 4,000 cubic feet per second;

TABLE 3

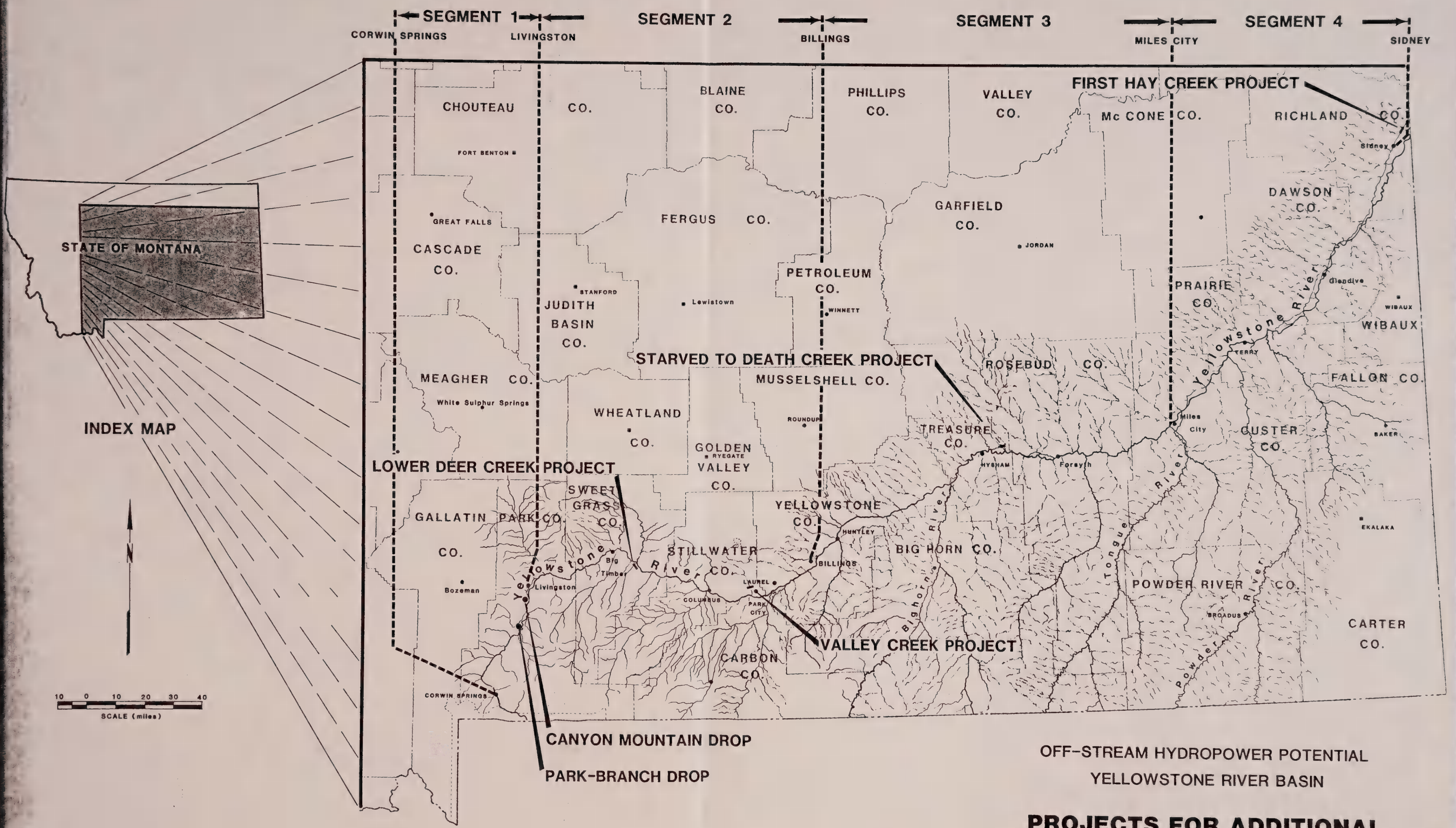
EVALUATION OF SIXTEEN SITES
YELLOWSTONE RIVER BASIN

PROJECT NAME	SITE DATA			
	RIVER SEGMENT	ENVIRON-MENT (1)	OWNERSHIP PERCENT PRIVATE (2)	STORAGE AT NORMAL POOL (AC-FT) (3)
PARK-BRANCH CANAL DROP	**1**	**4 A**	**87**	—
CANYON MOUNTAIN DROP	**1**	**3 A**	**100**	—
PRAY SIDING DROP	1	7 B	95	—
LOWER DEER CREEK	**2**	**1 A**	**98**	**34,000**
CALAMITY JANE	2	5 B	100	31,000
TRAIL CREEK	1	16 C	87	82,000
FIRST HAY CREEK	**4**	**14 B**	**97**	**3,300**
BRIDGER CREEK	2	2 A	98	90,000
FOX CREEK	4	15 B	84	5,150
VALLEY CREEK	**2**	**6 B**	**100**	**132,000**
SWEENEY CREEK	3	10 B	100	144,000
SUNDAY CREEK	4	12 B	96	585,000
STARVED TO DEATH CREEK	**3**	**9 B**	**97**	**144,700**
DEER CREEK	4	13 B	86	26,340
MOON CREEK	3	11 B	100	130,100
FROZE-TO-DEATH CREEK	3	8 B	91	47,000

Bold type denotes six selected sites

(1) NUMBER DESIGNATES RANKING OF PROJECTS CONSIDERED (1=Least Negative Impact, 16=Most Negative Impact); LETTER DESIGNATES ENVIRONMENTAL IMPACT (A=Moderate, B=Substantial, C=Extensive)

(2) ALONG EXPECTED RIGHT OF WAY OF CONVEYANCE FACILITY ROUTE AND PROJECT SITE.



OFF-STREAM HYDROPOWER POTENTIAL
YELLOWSTONE RIVER BASIN

PROJECTS FOR ADDITIONAL EVALUATION

FIGURE 2

select the sig
results

-- alternative sizes of off-stream reservoir storage capacity at each site; and

-- alternative sizes of penstock and generator capacity at each site.

TABLE 4

PROJECT SELECTION

YELLOWSTONE RIVER BASIN

PROJECT NAME	RIVER SEGMENT	REVISED COSTS			HYDROPOWER POTENTIAL			ANNUAL AVERAGE DIVERSION (AC-FT)	STORAGE CAPACITY (AC-FT)
		TOTAL CONSTRUCTION COSTS (1)	COST PER KILOWATT HOUR (2)	PRESENT VALUE REVENUES (3)	PLANT CAPACITY (MW)	AVERAGE ANNUAL ENERGY (KWH)	PLANT CAPACITY FACTOR (4)		
PARK BRANCH CANAL DROP	**1**	$53,200,000	0.0316	$79,153,800	55	127,800,000	0.27	586,000	—
CANYON MOUNTAIN CANAL DROP	**1**	$27,000,000	0.0409	$21,788,200	15	50,000,000	0.27	586,000	—
LOWER DEER CREEK	**2**	$115,200,000	0.0583	$26,358,500	41	150,000,000	0.28	622,500	34,000
VALLEY CREEK	**2**	$175,000,000	0.1144	$ – 94,848,500	35	116,000,000	0.27	582,000	132,000
STARVED TO DEATH CREEK	**3**	$123,400,000	0.1710	$ – 100,909,000	20	54,800,000	0.32	697,000	144,700
FIRST HAY CREEK	**4**	$50,800,000	0.0531	$20,104,000	7.5	72,700,000	0.61	1,337,000	3,300

(1) TOTAL CONSTRUCTION COSTS INCLUDE: DIVERSION, CONVEYANCE FACILITY, DAM AND HYDROPOWER FACILITIES (1981 Dollars)

(2) ANNUAL REPAYMENT COST DIVIDED BY AVERAGE ANNUAL ENERGY

(3) BASED UPON PRELIMINARY COST OF SERVICE CALCULATION: Finance Rate 7-3/8%, Annual Cost Escalation 6%, Initial Operation and Maintenance 4%, Initial Revenue from Service Worth Between $0.035/Kwh and $0.0621/Kwh, 50-Year Project Life.

(4) ACTUAL ENERGY PRODUCED DIVIDED BY PLANT CAPACITY POTENTIAL.

The results of the comparative reevaluation of the six sites are shown in Table 4. It should be noted that the figures listed in the table for the Lower Deer Creek and Starved to Death Creek project sites were later revised as a result of more detailed investigations. The revised figures are presented in Chapters 3 and 4.

A brief description of the physical characteristics of the six potential sites considered for feasibility study is presented in Appendix B.

SELECTION CONCLUSIONS

Reassessing the development potential of the remaining six sites led to the conclusions listed below. Each potential project site was rated according to its suitability for use as an off-stream hydroelectric project. From this rating, one site was selected for feasibility study. This site would receive a higher level of investigation concerning engineering constraints, environmental impacts, and the economic feasibility of a project at the site.

1. Park-Branch Canal Drop. The Park-Branch Canal Drop site was rated as the site with the greatest potential for off-stream hydropower development. This site received the highest rating because:

    a) projected unit energy costs were the lowest of all potential projects studied;
    b) present value revenues showed the greatest return on dollars invested;
    c) annual energy production at the site would be very high (second only to the Lower Deer Creek site);
    d) the potential for irrigating additional lands was reasonably high (such use might be designated as a secondary benefit of the project);
    e) impacts on fish and wildlife resources would probably be moderate;

f) much of the right of way needed to construct the project was previously acquired as a right of way for the state-owned Park-Branch Canal project.

Although the Park-Branch Canal Drop site showed the greatest potential for development, it was dropped from further consideration in this investigation because adding hydroelectric facilities to the existing Park-Branch Canal project could be considered under the state's current project rehabilitation program. In addition, the project proposed for this site would not include a storage facility, as required by House Bill 861.

2. Lower Deer Creek. The Lower Deer Creek site showed the second highest potential for hydropower development and, because the Park-Branch Canal Drop site was dropped from further consideration, was the site selected for more detailed study. The site received its high rating because:

a) potential annual energy production at the site was the highest of the six sites selected for final consideration;
b) present value revenues showed the second highest rate of return on dollars invested (only the Park-Branch Canal Drop project would offer a greater rate of return;
c) projected unit energy costs were the second lowest of all the projects offering a storage capacity (only a project at the First Hay Creek site would have lower unit energy costs);
d) the project received the highest overall environmental rating of all the projects studied (impacts on fish and wildlife resources would probably be moderate);
e) the potential for irrigating additional lands was the highest of the six sites selected for final consideration (such use might be designated as a secondary benefit of the project);
f) the hydraulic head available for hydropower production was the largest offered by the projects studied.

3. Starved to Death Creek. The Starved to Death Creek site received the third highest rating for development potential. The site received this rating because:

   a) the project showed a potential for increasing hydropower revenues through daily and seasonal hydropower production scheduling (the large storage capacity of the project reservoir would allow water to be stored for release during high-demand periods);

   b) the land on which the project would be constructed is generally of low quality and its loss through project construction would not cause significant impacts on the local community;

   c) the potential for irrigating new lands would be high (such use might be designated as a secondary benefit of the project).

Unlike the two higher rated sites, the projected unit energy costs for electricity from a project at this site were high (the highest of the final six projects considered). In addition, the impact of project construction on fish and wildlife resources at this site could be significant; eight of the 16 potential hydropower sites originally investigated were thought to have potentially fewer environmental impacts. Thus, this site was rated lower than the first two.

Because the value of a large storage reservoir for off-stream hydropower projects has not been firmly established, the Starved to Death Creek project was recommended for additional investigation concerning the value of "peaking" power production. This analysis, along with refined dam and reservoir cost estimates from the U.S. Bureau of Reclamation, was expected to provide a better estimate of the proposed project's hydropower producing potential.

4. Valley Creek. The Valley Creek site, rated fourth in the feasibility study project selection process, proved to be very similar to the Starved to Death Creek project in the final assessment. Both sites would offer large storage reservoirs, both exhibited present value revenues that indicated a potential loss of greater than $90 million over 50 years, and both would probably feature energy unit costs greater than 100 mills per kilowatt hour.

   Nevertheless, a project at the Valley Creek site could conceivably produce over twice as much average annual energy as could a project at the Starved to Death Creek site, and the environmental impacts of construction at the Valley Creek site probably would be fewer. The Valley Creek site was rated slightly lower than the Starved to Death Creek site, however, because the supply canal to the Valley Creek project would have to cross Interstate 90 11 times and because the proposed Valley Creek project would have the highest total construction cost of the six projects assessed in the final evaluation.

5. First Hay Creek. The First Hay Creek site was rated lower than the four higher rated sites primarily because it received a very poor environmental rating. The impacts on fish and wildlife resources brought about by project construction probably would be substantial; only three of the 16 potential hydropower sites originally investigated were assigned lower environmental rankings.

   It should be noted, however, that total project costs and unit energy costs for a project at the First Hay Creek site would be lower than for projects at most of the other sites studied. A project at this site also would show a return of around $20 million over the expected 50-year life of the project.

6. Canyon Mountain Canal Drop. A project constructed at the Canyon Mountain Canal Drop site would be very similar to one constructed at the Park-Branch Canal Drop site. In fact, if one project were

constructed, the other could not be; because there is not enough excess water in the affected reach of the Yellowstone River to supply both projects. Both projects would offer low unit energy costs, and both would be expected to have moderate impacts on fish and wildlife resources.

Nevertheless, the Canyon Mountain Canal Drop site received a lower rating than the other five sites considered for feasibility study because a project at the Park-Branch Canal Drop site would offer a better return on the initial investment and because a project there could open up more new lands to irrigation. Also, a canal to the Park-Branch site would follow an existing canal right of way, whereas a canal to the Canyon Mountain project would not.

Due to the advantages evident in constructing a project at the Park-Branch Canal Drop site, a project at the Canyon Mountain Canal Drop site should be considered only as an alternative to a project at the Park-Branch site.

CHAPTER III

THE LOWER DEER CREEK PROJECT

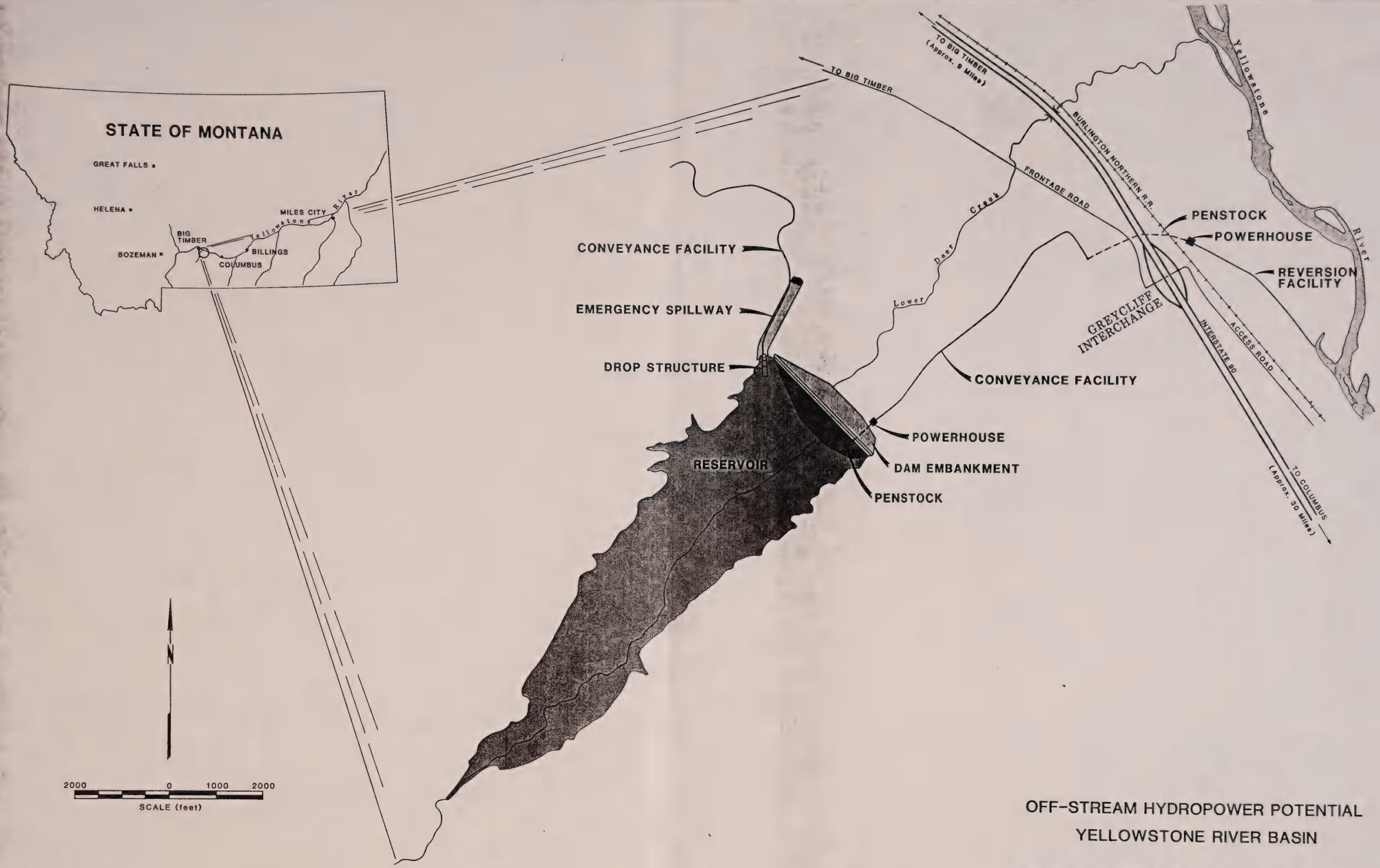
After the Lower Deer Creek site was selected for more detailed study, preliminary engineering design studies were initiated.

The objectives of these studies, as outlined in House Bill 861, were to:

1. develop a project design that would divert peak flows, use gravity flow, provide off-stream storage, and produce hydropower without consuming water;
2. conduct a preliminary environmental impact assessment to identify the requirements for full-scale environmental impact analysis;
3. assess the permitting and licensing requirements for the potential hydropower facility;
4. identify potential hydropower marketing alternatives;
5. prepare a preliminary economic review and analysis.

PROJECT CONCEPT AND DESCRIPTION

The proposed Lower Deer Creek project, shown in Figure 3, would lie in portions of both Park and Sweet Grass counties. Major project features include: a diversion structure on the Yellowstone River near Springdale; a 35.7-mile-long concrete-lined canal to convey diverted water by gravity from the Yellowstone River to the project's storage reservoir; a storage reservoir in the Lower Deer Creek drainage near Greycliff; and two hydroelectric generation facilities -- one at the proposed dam and another along the outflow from the dam -- that will produce energy as the water returns to the Yellowstone River. A second diversion facility would transfer excess Boulder River flows into the Lower Deer Creek canal to supplement flows from the Yellowstone River. A data summary of the components of the Lower Deer Creek project is presented in Table 5.



OFF-STREAM HYDROPOWER POTENTIAL

YELLOWSTONE RIVER BASIN

DEMONSTRATION PROJECT

LOWER DEER CREEK

FIGURE 3

TABLE 5

DATA SUMMARY — LOWER DEER CREEK PROJECT
YELLOWSTONE RIVER BASIN

DIVERSION	Maximum Diversion Capacity	3,000 CFS
	Average Annual Diversion	599,000 AC - FT
CONVEYANCE	**CANAL**	
	CONCRETE LINED CANAL	35.7 MI
	STRUCTURES	
	CROSS DRAINAGE	62
	RAILROAD CROSSINGS	1
	INTERSTATE HIGHWAY CROSSINGS	2
	PRIMARY, SECONDARY, COUNTY ROAD CROSSINGS	29
	IRRIGATION CANAL CROSSINGS	7
DAM	EMBANKMENT VOLUME	7.1 MILLION CU YDS
	HEIGHT	180 FT
	LENGTH	3,200 FT
	CREST WIDTH	40 FT
	OUTLET PENSTOCK CAPACITY	2,750 CFS
SPILLWAY	PRINCIPAL: OUTLET	2,750 CFS
	EMERGENCY: TO PINE TREE GULCH	46,000 CFS
HYDROPOWER FACILITIES	**POWERHOUSE AT DAM**	
	EFFECTIVE HEAD	145 FT
	PLANT CAPACITY	29 MW
	POWERHOUSE AT YELLOWSTONE RIVER	
	EFFECTIVE HEAD	150 FT
	PLANT CAPACITY	31 MW
	COMBINED POWERHOUSES	
	AVERAGE ANNUAL ENERGY PRODUCTION	150 MILLION KWH
	CAPACITY FACTOR	0.25
RESERVOIR	NORMAL STORAGE CAPACITY	34,000 AC - FT
	ACTIVE HYDROPOWER STORAGE	25,000 AC - FT
	NORMAL SURFACE AREA	540 AC

As designed, the project would use only those river flows in excess of prior water rights and existing water reservations. In an average year, the project would divert 499,000 acre-feet of water from the Yellowstone River and another 100,000 acre-feet from the Boulder River. Instream flow levels, set by the Board of Natural Resources and Conservation, would be maintained in the affected reaches of the Yellowstone and Boulder rivers whenever the project was in operation. If river flows dropped below set instream flow levels, project diversions would cease.

Diversion Facilities

The Yellowstone River diversion structure would be located one mile west of Springdale. A maximum flow of 3,000 cubic feet per second (cfs) would be diverted south of the river into the proposed Lower Deer Creek canal. The diversion structure selected for use is designed to preserve the existing river bed cross section without protruding above the natural river bed. A concrete slab conforming to the shape of the river's bed would direct water into the canal at an existing bend in the river. This unconventional design would allow fish and floater passage and preserve the free-flowing characteristics of the river.

Diversions from the Yellowstone River would be controlled by radial gates. To ensure that water would be diverted only when flows were in excess of instream flow levels, the canal inlet would be placed above the instream flow level. Provisions to permit trash removal and ice passage at the canal inlet are planned.

The diversion structure on the Boulder River, five miles above its mouth, would have a capacity of 500 cfs. This structure would be of the same design as the Yellowstone River diversion. Since only flows in excess of instream flow reservations would be used, a diversion structure extending above the river bed would not be required.

Flows from the Boulder River would increase hydropower production at the Lower Deer Creek project by approximately 20 percent. Water would be diverted from the Boulder River during the fall and winter, when only limited flows could be diverted from the Yellowstone River.

Conveyance System

Water from the diversion point on the Yellowstone River near Springdale would be conveyed through 35.7 miles of canal to the storage reservoir. This canal, which would have a concrete lining and carry a designed capacity of 3,000 cfs, would be 82 feet wide at the top, 23 feet wide at the bottom, and 20 feet deep. All sections of this Lower Deer Creek canal would be fenced. Bridge crossings are proposed at 29 locations.

Water diverted from the Boulder River would enter a 1/2-mile-long concrete-lined canal. This feeder canal, which would be 30 feet wide at the top, 7 feet wide at the bottom, and 7½ feet deep, would join the larger Lower Deer Creek canal near the point at which the larger canal crosses the Boulder River. As with the Lower Deer Creek canal, all sections of this feeder canal would be fenced.

In general, Yellowstone River water would be diverted from May through October, while Boulder River water would be diverted from October through May. Since water in the Boulder River is available for winter diversions, and since draining the canals in winter could cause frost damage and trash accumulation, both canals would be kept full whenever possible. A series of six check gates on the Lower Deer Creek canal would maintain the water level in the canal and allow each canal section to be controlled independently. Such a design would allow the canal to be cleaned and maintained on a regular basis.

A comparison of canal versus buried pipe costs indicated that an open canal system at Lower Deer Creek would be much cheaper to construct than would a large-diameter buried pipe water-supply system. The cost of a canal system to the Lower Deer Creek site would be around $42.4 million, which would contribute to a total design and construction cost for the project of $165 million. In contrast, a buried pipe system for conveying water to the site would cost around $376.2 million, leading to a total design and construction cost of about $594.6 million. This information led to the selection of an open canal for most of the conveyance route.

Storage

An earthfill dam on Lower Deer Creek about two miles upstream from Greycliff would form a reservoir that would store approximately 34,000 acre-feet of water. This dam, which would be 180 feet high, 3,200 feet long, and 40 feet wide at the crest, would require around 7.1 million cubic yards of earthfill to construct. Satisfactory foundation materials, sources of earthfill, and associated construction materials for the dam have been identified near the proposed dam site.

The dam structure would include an emergency spillway conforming to the current safety criteria for high-hazard dams. The spillway would be able to pass a maximum of 46,000 cfs, a flow which would be encountered only under the most extreme flooding conditions.

When full, the reservoir would inundate about 540 acres of land currently used for dryland pasture and irrigated hay production. Since the primary purpose of the Lower Deer Creek project would be to generate hydropower, the reservoir would be operated as a draw-down storage facility. In other words, water levels in the reservoir would fluctuate as the reservoir drains and refills. Of the 34,000 acre-feet of normal reservoir storage, approximately 25,000 acre-feet would be used for generating hydropower. Because water levels in the reservoir would rise and fall intermittently, the proposed Lower Deer Creek reservoir probably would be unsuitable for many types of water-based recreation.

Hydropower Facilities

The 180-foot-high dam would provide 145 feet of effective head to drive a power plant at the toe of the dam. Elevation drop along the lower-most 2,600 feet of the reversion route back the Yellowstone River would provide an additional 150 feet of effective head to drive a second power plant. This plant would be located near the point of return flow discharge into the Yellowstone River. The combined capacities of the two Lower Deer Creek powerhouses could total a maximum of 60 MW and produce 150 million kilowatt hours of electricity annually. Transmission lines from the Lower Deer Creek project could join the nearest switching facility at Big Timber, 11 miles west of the dam site.

PRELIMINARY ENVIRONMENTAL ASSESSMENT

A preliminary environmental assessment of the proposed Lower Deer Creek project did not reveal any major environmental concerns that might prevent construction of the project. However, these preliminary studies did identify several concerns that would have to be investigated more fully during the course of preparing a full-scale environmental impact statement. Because the purpose of the studies was to make only a preliminary assessment of potential environmental impacts, primary emphasis was placed on assessing those impacts that would affect fish and wildlife resources.

The Existing Fishery Resource

The section of the Yellowstone River that would be affected by the Lower Deer Creek project is nationally renowned for its fishery. The Montana Department of Fish, Wildlife and Parks has classified the fishery resource in this reach of the Yellowstone as Class 1, or of the highest value. Brown and rainbow trout are abundant in this reach. The cutthroat trout, a species of special concern in the Yellowstone River Basin, is present, although rare, in this reach.

The fishery in the section of the Boulder River that would be affected by the project also is substantial. Brown and rainbow trout are abundant in this reach and reside here throughout their life cycles.

Like the fishery in the Yellowstone and Boulder rivers, the fishery resource in the part of Lower Deer Creek that would be affected by the proposed project also is significant. Brown and brook trout are common in the stretch of the creek that would be occupied by the dam-reservoir complex. Although Yellowstone cutthroat trout are rare in this stretch, they do occasionally occur throughout their life cycle.

Because Upper Deer Creek would be crossed by the proposed Lower Deer Creek canal, it also might be affected by project development. Like Lower Deer Creek, this creek offers a fishery for brown and brook trout. However, the value of its fishery has been rated as "limited" by the Montana Department of Fish, Wildlife and Parks. Removal of instream flows for irrigation is thought to be the limiting factor in this case.

A number of other small tributaries of the Yellowstone would be crossed by the proposed Lower Deer Creek canal. Because all flow intermittently and no fishing information is available for them, the value of their fisheries is assumed to be insignificant.

The Existing Wildlife Resource

The area in which the proposed Lower Deer Creek project would be constructed is home to many species of wildlife. Antelope, which range freely on the benches above the Yellowstone River and on the sagebrush flats along the river's edge, move back and forth between these areas along the entire length of the proposed Lower Deer Creek canal. Mule deer are common in the same areas, and upland game birds are abundant throughout the area. Migrating waterfowl commonly rest on this portion of the river and feed in nearby fields. Furbearers live along the entire length of the Yellowstone and along many of its tributaries.

Potential Impacts on the Fishery

To maintain the quality of the fishery resource and the aquatic environment on which it depends, four priorities should be established during project construction: 1) fish passage for spawning should not be impaired since trout move up and down the Yellowstone into tributaries to spawn; 2) riffle areas used for spawning and feeding should be left intact; 3) rearing pools, which provide a place for fish to rest and grow, also should be maintained; and 4) alterations in stream flow should be limited so that temperature fluctuations, dissolved oxygen levels, and sediment loads do not cause insects to drift out of riffle areas and be excessively preyed upon by fish.

An important component of the diversion structures on the Yellowstone and Boulder rivers is the concrete slab laid across the entire width of the channel that would act as a bed stabilizer. Such a structure should not present a barrier to fish movement. Investigations by the Montana Department of Fish, Wildlife and Parks indicate that rainbow and brown trout are suspected of spawning and rearing in the lower reach of the Boulder River. These activities also should not be impaired by the proposed bed stabilizer.

The intake facilities that would direct water into the canals might also direct fish into the canals. Although these fish could eventually end up in the reservoir, it is difficult to say how many would take this route. Further studies of the potential for fish movement into the reservoir and the reservoir's suitability as fish habitat would be needed to determine whether a structure to block fish passage might be necessary.

Because the proposed diversion structures would take advantage of the slope and natural fall of the river bed, little or no rapids would be created. As a result, the structures should not present an obstacle to fish or floaters passing the diversion.

Since the water withdrawn for the canal system would be over and above the instream flow requirements for both the Yellowstone and Boulder rivers, no dewatering of riffles or rearing pools is currently anticipated. However, the return of water to the Yellowstone from a power generating complex might present some problems for the fishery. Water returned to the river from the dam could alter flows and water levels in a way that would adversely affect the populations of aquatic organisms on which fish feed. Because acceptable fluctuations in water levels have not been defined, the actual effects such inflows would have on the Yellowstone fishery are not known. Subsequent investigations should address this concern.

Some other potential impacts on the fishery are apparent. First, the planned reservoir could eliminate potential habitat for the Yellowstone cutthroat trout on Lower Deer Creek. In addition, fish passage between the creek's upstream sections and the Yellowstone River would be eliminated. It should be noted that Lower Deer Creek already suffers from sizable water fluctuations due to water withdrawals for agriculture. This condition, in itself, may limit the fishery. Thus, improvements in the fishery are not likely.

In this project, large-diameter buried pipe would be used to channel water in the canal beneath the Boulder River and Upper Deer Creek; culverts would be used to channel natural runoff beneath the canal as it crosses all smaller tributaries. All crossings would, therefore, alter existing streambeds. This should not cause a problem if the substrate material is stable. If it is not stable, sloughing and streambed degradation may occur. If the project were to be built, further geologic investigations would be necessary to determine the suitability of the planned crossing methods.

Potential Impacts on the Wildlife Resource

A major concern for the wildlife resource would be the inability of antelope to cross the canal from the Yellowstone River. A canal of the size and length planned for this project would essentially prevent antelope from moving between the benches and flats along the river. As a result, the canal might break the existing antelope herds into different population segments. In addition, although the canal will be fenced, animals may fall into the canal and drown. Possible solutions would be to construct a series of bridges across the canal or to install sections of buried pipe.

These as well as other environmental concerns will have to be investigated more fully during the preparation of an environmental impact statement.

PERMITTING AND LICENSING REQUIREMENTS

At present, if a hydropower project of 50 MW or more were to be constructed at the Lower Deer Creek site, the developer would be required to submit an application for a Certificate of Public Need and Environmental Compatibility to DNRC, as mandated by the Montana Major Facility Siting Act (MFSA). This application would have to be preceded by a long-range plan for the project, which must be submitted to DNRC at least two years before the application for the siting certificate is submitted.

The application submitted in compliance with the MFSA must include project design information, an economic analysis of the proposed project, an assessment of the need for the project, an assessment of alternative techniques that might satisfy the need, an assessment of potential environmental and socioeconomic impacts, a description of possible alternative locations for the project, and a statement as to why the preferred location is best suited for the facility. DNRC will review the application and, if it accepts the application, will begin work on an environmental impact statement for the project. It is important to note that even if the Lower Deer Creek project were sized to produce less than 50 MW of power, an environmental impact statement for the project would undoubtedly still have to be prepared, as required by the Montana Environmental Policy Act.

When completed, the application and the final environmental impact statement with recommendations are forwarded to the Board of Natural Resources and Conservation. The board decides whether to deny or grant the siting certificate. The entire certification process, from the time an application is received until a certificate is granted or denied, may take up to 36 months to complete.

In addition to the costs incurred in preparing the application, the project's developer also would have to pay an MFSA filing fee. This fee, which is imposed to cover the costs of reviewing the application and issuing a siting certificate, would probably be around $1.2 million for the Lower Deer Creek project.

As the process is designed, most of the state's permitting requirements, could be met under, and would in effect be superseded by, the requirements of the MFSA. A water right for the project would have to be applied for separately. Permits under the jurisdiction of the Montana Department of Health and Environmental Sciences and its parent Board of Health and Environmental Sciences would be reviewed and issued as a part of the overall MFSA process.

Federal siting requirements for the Lower Deer Creek project would be satisfied through the Federal Energy Regulatory Commission (FERC) "major" licensing process. Because much of the information required to obtain a license from FERC is similar to that required to obtain an MFSA siting certificate, the amount of additional study needed to prepare the FERC application should be limited. To minimize the costs of preparing information to meet the requirements of both the MFSA and FERC, the informational needs of both should be considered.

FERC does not at this time assess a filing fee to license applicants. However, owners of a licensed facility are required to pay an annual fee to FERC to cover the cost of program administration.

HYDROPOWER MARKETING ALTERNATIVES

Several groups can be viewed as potential purchasers of the energy produced at the Lower Deer Creek site. The Montana Power Company (MPC) is considered a good prospect, since the project would lie within the company's service area. Also, rural electric cooperatives could purchase power from the project if their service demands were large enough to require power from a 50 to 60 MW plant. In addition, the Western Area Power Administration could potentially integrate Lower Deer Creek power into its transmission system and reshape its distribution according to customer demands. Lastly, the energy produced could be sold directly to a large industrial user.

At present, serious purchase negotiations with prospective buyers of Lower Deer Creek power would be limited for two major reasons. First, energy demands in the region are less than they were forecasted to be. Such changes in demand make it difficult to estimate the need for and value of energy from a source that will not be producing power until sometime in the distant future. Second, the detailed power production and cost information needed to establish sales rates for Lower Deer Creek power is not available at this time. Since the exact value of Lower Deer Creek power cannot be determined, a range of values, based on discussions with Montana Power Company and an analysis of current Montana Public Service Commission (PSC) regulations, is presented.

Discussions with the Montana Power Company have indicated that Lower Deer Creek power would be produced primarily during the spring and summer, when a substantial amount of hydropower from existing facilities in the Pacific Northwest region is available. In addition, the utility's highest peak load demands are during the winter months, when the project at Lower Deer Creek would produce relatively little power. Because the power produced at the Lower Deer Creek site would not satisfy Montana Power Company's peaking power needs, and because the power produced would have to be compared to production from existing hydropower facilities, Montana Power Company estimates that the power produced at the site would be worth $0.0125 per kilowatt hour (kWh), or 12.5 mills per kWh.

Current PSC regulations state that the power produced by qualifying (under 50 MW) small hydropower projects must be purchased at rates set by the commission. The Lower Deer Creek project would be a qualifying facility if its generator capacity were sized at under 50 megawatts. Considering a 49 MW plant and current PSC regulations, the local utility (Montana Power Company) would be required to pay $0.0611 per kWh (61.1 mills per kWh) under a long-term purchase agreement for energy produced at the Lower Deer Creek site.

A comparison of Montana Power Company's purchase rate estimate and PSC's regulatory rate indicates that a broad range of values -- from $0.0125 per kWh (Montana Power Company) to $0.0611 per kWh (Public Service Commission) – exists. Many utilities subject to regulatory constraints like those of the

Public Service Commission have argued that such regulations assign small power producers peaking power rates for nonpeaking power. (It is possible that the PSC will consider peaking power rates when establishing future rate schedules; such a consideration could lower the regulated value of Lower Deer Creek power to a point less than $0.0611 per kWh.) On the other hand, some small power producers have argued that utilities should consider the avoided cost of power from their next scheduled thermal power plant construction rather than the cost of power from existing facilities when establishing rates for power produced from small hydropower projects.

Considering the different points of view and the potential market changes, it is difficult to assess the actual value of the power that would be produced at the Lower Deer Creek site. This uncertainty grows when taking into account the six- to ten-year period before power from the project would be available.

PRELIMINARY ECONOMIC ANALYSIS

A range of finance rates, typical for public projects, was used to compare hydropower revenues with project costs. Assessing the repayment capacity of a single benefit (hydropower production) gives an indication of the revenue shortfall or surplus that might be expected from this single benefit over the project's economic life. However, a preliminary economic analysis of the proposed Lower Deer Creek project does not provide the complete benefit/cost assessment needed to accurately judge the project's total economic feasibility. It is important to note that other potential benefits, such as increased irrigation opportunities, were not assessed in this analysis. Additional uses or benefits of diverted water, besides hydropower production, could enhance the economic outlook for the project.

Cost of Service Analysis

A cost of service analysis was used to estimate revenues over the project's expected 50-year economic life. A 25-year bond period was assumed for this analysis. Finance rates of 8, 10, and 12 percent, were investigated.

Annual costs, such as those for operation, maintenance, and replacement (OMR), were escalated at a rate of 7.66 percent for the first 10 years, 4.28 percent for the next 10 years, and 4.22 percent for the final 30 years of the project's expected economic life. These inflation rates correspond to U.S. Department of Energy forecasts.

Two values for hydropower were used--$0.0125 per kWh and $0.0611 per kWh--to demonstrate the effect of current PSC regulations on project revenues, as discussed in the Hydropower Marketing Alternatives section. These rates were escalated in the same manner as OMR costs. Project costs, including bond repayments and OMR costs, were subtracted from annual hydropower revenues for each year of project operation. The differences between annual costs and annual revenues were used to calculate a present worth value for the project for each year of the project life. Present worth is a concept by which a project's ability to pay for itself over a period of time may be evaluated. In years where the analysis revealed annual costs exceeding annual revenues, the deficit in the annual repayment obligation was made up by borrowing the deficit amount for one year at 8 percent interest. The total annual deficit was refinanced at an interest rate of 8 percent annually for each successive year that a deficit occurred.

A present worth of revenues over a 50-year project life was calculated for each of the Lower Deer Creek project alternatives (see Table 6), taking into consideration refinancing of the deficits on an annual basis. The present worth values shown on Table 7 for two project alternatives are based on a 25-year bond period at finance rates of 8, 10, and 12 percent and annual deficit refinancing at 8 percent, and are cumulative for each alternative's project life.

Project Alternatives

The two project alternatives, described below, were considered in the economic analysis of the proposed Lower Deer Creek project. Each alternative was assumed to include the same diversion facility and conveyance route. The differences are in generator capacities and canal sizes. A breakdown of project costs is presented in Table 6.

TABLE 6

CAPITAL COSTS — LOWER DEER CREEK PROJECT
YELLOWSTONE RIVER BASIN

	LDC-1 Alternative	LDC-2 Alternative
LAND AND LAND RIGHTS	$ 1,762,000	$ 1,550,000
STRUCTURES AND IMPROVEMENTS	10,964,000	9,690,000
CONVEYANCE FACILITY	48,009,000	42,430,000
ROADS, RAILROADS AND BRIDGES	4,772,000	4,220,000
DAM AND RESERVOIR	19,531,000	17,260,000
EMERGENCY SPILLWAY	2,108,000	1,860,000
OUTLET WORKS AND PENSTOCKS	26,526,000	23,450,000
TURBINES AND GENERATORS	24,066,000	21,270,000
ACCESSORY ELECTRIC EQUIPMENT	1,600,000	1,410,000
MISCELLANEOUS POWER PLANT EQUIPMENT	1,200,000	1,060,000
SUBSTATIONS AND SWITCHING	1,100,000	970,000
TRANSMISSION LINES AND CONDUCTORS	2,500,000	2,230,000
SUBTOTAL ESTIMATED COSTS	$144,138,000	$127,400,000
UNESTIMATED CONTINGENCIES @ 15%	21,621,000	19,100,000
TOTAL ESTIMATED COST	$165,759,000	$146,500,000
MOBILIZATION COST @ 6%	9,946,000	8,800,000
TOTAL ESTIMATED COST OF CONSTRUCTION	**$175,705,000**	**$155,300,000**
ENVIRONMENTAL IMPACT STATEMENT	1,000,000	1,000,000
ENGINEERING DESIGN @ 5.6%	9,839,000	8,700,000
TOTAL DESIGN AND CONSTRUCTION COST	**$186,544,000**	**$165,000,000**

Alternative LDC1 includes a 60 MW power plant and a 34,000-acre-foot storage reservoir. This alternative would provide the greatest average annual energy production of the two alternatives studied (150 million kWh). The total cost for LDC1 was estimated at $186,543,000.

Alternative LDC2 includes a 49 MW power plant and a 34,000-acre-foot storage reservoir. This alternative would produce 132 million kWh of energy at a total cost of approximately $165,000,000. Because this facility would produce less than 50 MW of power, it would qualify as a small

TABLE 7

PRESENT WORTH ANALYSIS - LOWER DEER CREEK PROJECT
YELLOWSTONE RIVER BASIN

Alternative	Major Features (1)	Bond Rates (2)	Energy Value $/KWH (3)	Annual Energy Production (mil.KWH) (4)	Total Present Worth with Deficit Financing (5)
	60 MW plant				
LDC1-A	34,000 AC - FT storage	8%	0.0125	150	$ – 1,292,480,000
LDC1-B		10%	0.0125	150	– 1,173,090,000
LDC1-C		12%	0.0125	150	– 1,104,820,000
	49 MW plant				
LDC2-A	34,000 AC - FT storage	8%	0.0611	132	$ – 169,713,000
LDC2-B		10%	0.0611	132	– 271,647,000
LDC2-C		12%	0.0611	132	– 337,074,000

(1) LDC2 was sized at 49 MW to qualify for PSC's "small power producer" rate structure (see Hydropower marketing alternatives section).

(2) A 25 year bond term was assumed for each alternative.

(3) Energy values and annual operation costs (OMR) were assumed to escalate 7.66% annually in the first 10 years, 4.28% annually in the next 10 years, and 4.22% annually in the next 30 years.

(4) Annual Energy Production is based on average annual diversions for the period of record.

(5) The Present Worth methodology is discussed in the **Cost of Service Analysis** section of this Chapter. Deficits at the end of any operating year (annual revenues - annual costs) are covered by annual loans with annual financing charges of 8 percent.

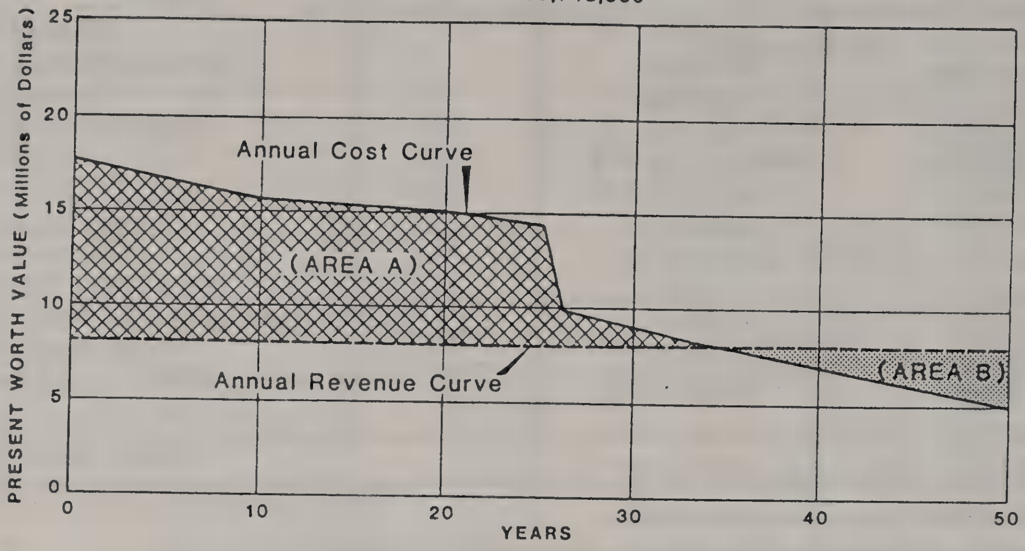
hydropower producer under current Public Service Commission (PSC) regulations. As a result, power produced by this facility could be sold at rates established by the PSC, as discussed in the Hydropower Marketing Alternatives section of this report.

Present Worth Analysis Results

The calculated present worth for each of the Lower Deer Creek project alternatives is summarized on Table 7. Negative present worth values indicate that a project may not produce enough revenue to offset project costs. Present worth values for alternative LDC1, based on a power purchase rate estimated by the Montana Power Company ($0.0125 per kWh), are all negative on Table 7. Present worth values for alternative LDC2, based on a

ASSUMPTIONS AND CONCLUSIONS

Capital Cost Financed at 8% Over 25 Years
Short Term or Annual Deficit Financing
Annual OMR .... = $ 1,710,000
Annual Revenue .... = $ 8,065,000
Net Present Worth Revenues   Annual Revenue Curve Minus Annual Cost Curve
Deficit at End of 50th Year
$ - 169,713,000



OFF-STREAM HYDROPOWER POTENTIAL
YELLOWSTONE RIVER BASIN
PRESENT WORTH ANALYSIS
LOWER DEER CREEK PROJECT
49 MEGAWATT FACILITY
FIGURE 4

power purchase rate subject to PSC regulation ($0.0611 per kWh), also are negative. Alternative LDC2-A (Table 7) is the most favorable alternative presented.

Present worth over the 50-year economic life of the LDC2-A alternative is displayed graphically in Figure 4. In this graph, the area above the annual revenue curve and below the annual cost curve (Area A, Figure 4) indicates the debt accrued over the initial bond repayment period. The area below the annual revenue curve and above the annual cost curve (Area B, Figure 4) indicates the amount of revenue accrued. The summation of debt and revenue represents the net present worth over the expected economic life.

The present worth analysis shows that the single-purpose hydropower projects investigated are economically sensitive to several factors. Factors greatly influencing the economic feasibility of the single-purpose hydropower projects include hydropower values and construction bond interest rates. Slight changes in hydropower purchase rates or construction bond interest rates greatly change the outcome of the present worth analysis. Assuming of other benefits in addition to hydropower revenues may result in positive present worth values.

CHAPTER IV

SUPPLEMENTAL INVESTIGATION OF THE STARVED TO DEATH CREEK SITE

As a supplement to the detailed studies at the Lower Deer Creek site, further investigations of the Starved to Death Creek site were conducted to refine the cost and hydropower revenue estimates for a project at this site. Initial reconnaissance-level studies indicated that power from this project would cost nearly three times as much as power from the Lower Deer Creek project. However, because a project at the Starved to Death Creek site would include a large storage reservoir, further analysis of potential increased revenue if the project were used to produce peaking power seemed merited.

It should be noted that the analysis of Starved to Death Creek site was not as comprehensive as the anaysis of the Lower Deer Creek site. The contractor did not conduct field investigations of the diversion site and canal route for the Starved to Death Creek project. However, valuable engineering and geologic information for the proposed dam site was supplied by the U.S. Bureau of Reclamation.

The proposed Starved to Death Creek diversion facility would be located on the Yellowstone River approximately 2.5 miles west of Custer in Yellowstone County. Water for the project would be diverted south of the river into a 3,000 cfs concrete-lined canal. This canal, which would cross under the Bighorn and Yellowstone rivers, would extend 44 miles to the proposed dam site. The dam, as proposed, would be located north of the Yellowstone River approximately 10 miles northeast of Hysham in Treasure County.

As was found to be the case in the Lower Deer Creek site investigation, a comparison of canal versus buried pipe costs indicated that an open canal water-supply system to the proposed Starved to Death Creek site would be much cheaper to construct than would a large-diameter buried pipe system. The cost of a canal system to the site would be around $80 million, which would contribute to a total design and construction cost for the project of about $136.2 million. A buried pipe system, on the other hand, would cost about $449.2 million to construct, leading to a total design and construction cost for the project of approximately $612.4 million. The much higher costs for a buried pipe water-transfer system led to the selection of an open canal system for most of the conveyance route.

The reservoir produced by an earthfill dam on Starved to Death Creek would store up to 125,000 acre-feet of water during normal operations. Maximum storage during a flood would be 144,000 acre-feet. At this capacity, the reservoir produced by the proposed dam would inundate 5,600 acres of low-quality rangeland. Flood flows in excess of the maximum reservoir storage capacity would enter Roach Coulee to the west. Normal reservoir releases would follow the existing channel of Starved to Death Creek to the Yellowstone River.

The 110-foot-high dam would provide a maximum effective head of 100 feet to drive a 20 MW generator. As a base-load power producer, the project would maintain an average storage capacity of 90,000 acre-feet and would produce an average of 58.5 million kWh of electricity annually. As a peaking power facility, the project would provide 20 MW of power during the area's peak power demand period -- January and February. Peaking operations would draw the reservoir down to a minimum level of 55,000 acre-feet. The reservoir would refill during the spring runoff period. Peaking operations also would reduce average reservoir storage to 72,000 acre-feet and reduce average annual energy production by 5 percent. However, overall revenues could be greater under a peaking power operation than under a base-load operation because of the potential for higher peaking power rates.

If the project were operated to produce 20 MW of power, as planned, the project would be recognized as a "qualifying facility" under current PSC regulations. As such, power from the facility could be sold at the regulated rate of $0.0637 per kWh, as discussed in the previous Hydropower Marketing Alternatives section. Because the project could be operated as a peaking power facility, power produced at the site might be sold to a local utility at or above this rate.

TABLE 8

CAPITAL COSTS — STARVED TO DEATH CREEK PROJECT
YELLOWSTONE RIVER BASIN

LAND AND LAND RIGHTS	$ 1,525,000
STRUCTURES AND IMPROVEMENTS	$ 1,622,000
CONVEYANCE FACILITY	$ 80,093,000
ROADS, RAILROADS AND BRIDGES	$ 4,599,000
DAM AND RESERVOIR	$ 8,164,000
EMERGENCY SPILLWAY	$ 500,000
OUTLET WORKS AND PENSTOCKS	$ 4,104,000
TURBINES AND GENERATORS	$ 3,238,000
ACCESSORY ELECTRIC EQUIPMENT	$ 852,000
MISCELLANEOUS POWER PLANT EQUIPMENT	$ 196,000
SUBSTATIONS AND SWITCHING	$ 517,000
TRANSMISSION LINES AND CONDUCTORS	$ 402,000
SUBTOTAL ESTIMATED COSTS	$105,812,000
UNESTIMATED CONTINGENCIES @ 15%	15,872,000
TOTAL ESTIMATED COST	$121,684,000
MOBILIZATION COST @ 6%	$ 7,301,000
TOTAL ESTIMATED COST OF CONSTRUCTION	**$128,985,000**
ENVIRONMENTAL IMPACT STATEMENT ENGINEERING DESIGN @ 5.6%	$ 1,000,000 6,223,000
TOTAL DESIGN AND CONSTRUCTION COST	**$136,208,000**

The environmental impacts associated with the proposed project on Starved to Death Creek are of concern. During peaking power operations, river stages below the project could fluctuate up to one foot in a short amount of time. No attempt was made in this study to assess the impact of these fluctations. An earlier assessment of fish and wildlife concerns for a base-load facility at the site indicated that impacts along the canal and reservoir also could be substantial. These potential impacts, as well as the impacts that could be brought about by peaking operations, should be carefully studied if project development at this site is pursued.

TABLE 9

PRESENT WORTH ANALYSIS - STARVED TO DEATH CREEK PROJECT

YELLOWSTONE RIVER BASIN

Alternative	Major Features	Bond Rates (1)	Energy Value $/KWH (2)	Annual Energy Production (M KWH) (3)	Total Present Worth with Deficit Financing (4)
	20 MW plant				
STDC-A	125,000 AC-FT Storage	8%	0.0637	58.5	$ – 435,524,000
STDC-B	125,000 AC-FT Storage	10%	0.0637	58.5	$ – 456,701,000
STDC-C	125,000 AC-FT Storage	12%	0.0637	58.5	$ – 472,537,000

(1) A 25 year bond term was assumed for each alternative.

(2) Energy values and annual operation costs (OMR) were assumed to escalate 7.66% annually in the first 10 years, 4.28% annually in the next 10 years, and 4.22% annually in the next 30 years.

(3) Annual Energy Production is based on average annual diversions for the period of record.

(4) The Present Worth methodology is discussed in the **Cost of Service Analysis** section of this Chapter. Deficits at the end of any operating year (annual revenues - annual costs) are covered by annual loans with annual financing charges of 8 percent.

The estimated capital cost of the Starved to Death Creek project has been set at $136,208,000. A breakdown of these costs is shown in Table 8. Annual operation, maintenance, and replacement costs for the project total $364,000.

An economic analysis of the proposed Starved to Death Creek project was conducted within the bounds of the present worth method. The methods used in this analysis were the same as those used in the economic analysis of the proposed Lower Deer Creek project.

Results of the present worth analysis of the proposed Starved to Death Creek project are displayed on Table 9 and Figure 5. For purposes of the analysis, a 25-year bond period at interest rates of 8, 10, and 12 percent was assumed. The results display a single project alternative incorporating a 20 MW plant and a 125,000 acre-foot reservoir. The value of hydropower was assumed to be $0.0637 per kWh. No distinction between base load and peaking power values was made.

ASSUMPTIONS AND CONCLUSIONS

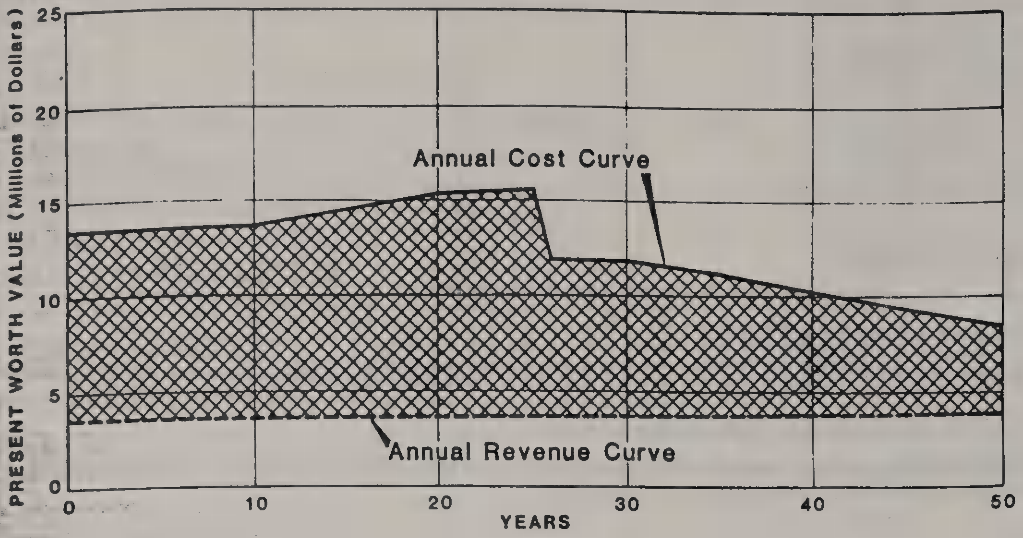
Capital Cost Financed at 8% Over 25 Years

Short Term or Annual Deficit Financing

Annual OMR .... = $ 364,000

Annual Revenue .... = $3,726,000

Net Present Worth Revenues = Annual Revenue Curve Minus Annual Cost Curve
= Deficit at End of 50th Year
= $-435,524,000



OFF-STREAM HYDROPOWER POTENTIAL
YELLOWSTONE RIVER BASIN

PRESENT WORTH ANALYSIS
STARVED TO DEATH CREEK PROJECT
20 MEGAWATT FACILITY
FIGURE 5

CHAPTER V
CONCLUSIONS

1. The Yellowstone River Basin has the physical potential to yield substantial supplies of hydroelectric power under the off-stream concept outlined in House Bill 861 (see page 3 of this report). Thirty off-stream sites with the potential to accommodate hydropower projects were identified in the study inventory process. Basic information from each site was compared in a screening process used to select the most suitable single site for more detailed study (see Tables 2, 3, and 4).

2. The water supply needed to operate a single project or a series of projects developed under the off-stream hydropower concept is available. However, large quantities of water generally are available only for relatively short periods of time from early spring through early summer. All water necessary to protect senior water rights, instream flow reservations, and consumptive use reservations was considered unavailable for use.

3. The conveyance facilities required to transport adequate supplies of water to off-stream locations for hydropower generation would be quite large. Canals 82 feet wide at the top, 23 feet wide at the bottom, and 20 feet deep would be needed to carry water from the river to potential generation sites. Most projects identified in this report would require canals over 30 miles long. These canals might disrupt the values associated with the individual farms they cross. Large diameter buried pipe could be used in place of canals to avoid disruption of farm operation. However, pipe conveyance is much more costly than canal conveyance and, thus, is considered cost prohibitive. For example, using buried pipe instead of a canal system to deliver water to the Lower Deer Creek site would increase the total design and construction cost of the project by around $430 million. Similar cost increases would be likely if a buried-pipe water-supply system were used in any of the other projects studied.

4. The Lower Deer Creek site in Sweet Grass County was studied in detail to demonstrate the feasibility of off-stream hydropower generation. Water for a project at this site would be diverted from the Yellowstone River near Springdale, Montana, and from the Boulder River near Big Timber, Montana. A 35.7-mile-long canal would convey diverted water to a 34,000 acre-foot storage reservoir in the Lower Deer Creek drainage. A return canal would carry project water back to the Yellowstone River near Greycliff, Montana, following hydropower generation. Alternative generator capacities of 49 megawatts and 60 megawatts were evaluated in the study. The 49-megawatt plant would yield the highest project revenues.

5. An environmental impact statement would be necessary under existing environmental protection statutes if development of the Lower Deer Creek project were pursued. Detailed information regarding the proposed action is required under the Federal Energy Regulator Commission major licensing process and the Montana Water Use Act. The project would also be subject to the requirements of Montana's Major Facility Siting Act if its design capacity were to exceed 50 megawatts. The permitting and licensing process, including environmental studies, would require approximately three years to complete after acceptance of initial applications by the reviewing agencies. Planning and construction of the Lower Deer Creek project could take up to ten years to complete.

6. Potential purchasers of Lower Deer Creek hydropower inlude the Montana Power Company, Montana rural electric cooperatives, the Western Area Power Administration, and possible large industrial electricity users. The extended development period and the lack of detailed production and cost figures make accurate power value projections impossible. Current estimates of the value of Lower Deer Creek power range from $0.0125 per kWh (Montana Power Company) to $0.0611 per kWh (Public Service Commission regulations).

7. The preliminary economic analysis of the Lower Deer Creek off-stream hydroelectric project indicates that development at the site is not economically feasible. The best alternative would yield a loss of $169,713,000

in 1982 dollars at the end of its fifty-year economic life (see Table 7, page 33). Hydropower was considered the only economic benefit in this analysis. Other major benefits resulting from a multipurpose project could improve the economic outlook for the project. However, identifying and assessing benefits other than hydropower was beyond the scope of this study.

8. The proposed Starved to Death Creek site in Treasure County was evaluated as a peaking power facility to determine if a lager storage reservoir could provide substantial supplies of peak period power. This analysis was not as comprehensive as that performed on the Lower Deer Creek project site.

9. Hydropower from the proposed Starved to Death Creek project could be marketed at $0.0637 per kWh under current Public Service Commission regulations. It is possible that peaking power from the project could be marketed at rates higher than the PSC value. Possible markets for peaking power were not identified in this investigation.

10. The potential environmental impacts associated with constructing and operaing a project at the Starved to Death Creek site are of concern. A preliminary assessment of basic fish and wildlife impacts from a baseload facility indicated that environmental effects along the canal and reservoir could be substantial. River fluctuations during peaking power operations are also a concern. An environmental impact study would be required if development at this site were pursued.

APPENDIX A

HOUSE BILL NO. 861

INTRODUCED BY HURWITZ, R. MANNING, SEVERSON, CONROY

AN ACT TO PROVIDE AN ANALYSIS OF THE FEASIBILITY OF GENERATING HYDROELECTRIC POWER AT OFF-STREAM SITES IN THE YELLOWSTONE RIVER BASIN, AND APPROPRIATING FUNDS FOR SUCH PURPOSE.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MONTANA:

Section 1 Purpose. The purposes of this act are to:

(1) demonstrate that the drainage system of the Yellowstone River can develop substantial supplies of clean hydroelectric power without disrupting the agricultural and other values associated with a free-flowing main stem of the river;

(2) demonstrate that off-stream hydroelectric capacity could be investigated within the framework of existing environmental protection statutes and could be implemented within the framework of and to the benefit of existing water rights and reservations; and

(3) direct consideration of, but not to decide at this time, how electricity so generated could be marketed.

Section 2. Duties of department. The department of natural resources and conservation shall, prior to January 1, 1983:

(1) formulate an overall project concept of one or more demonstrations involving the diversion, storage, and gravity-flow routing of annual peak period streamflows within the Yellowstone River Basin, with such routings culminating in hydroelectric installations and return of the waters to the streams;

(2) conduct preliminary environmental reviews of one or more sites for potential demonstration projects, to serve as baseline material for full-scale environmental impact analysis of such demonstration projects as may be selected for further funding or construction by future sessions of the legislature;

(3) conduct preliminary economic reviews of one or more such sites, evaluating alternate routes, capacities, and facilities with cost estimates suitable for formulating final design and construction budgets and analyzing cost-benefit ratios;

(4) analyze any licensing requirements that may be imposed by federal law; and

(5) consider, without recommendation and after consultation with public utilities and cooperatives that distribute electricity within the basin, various means by which hydroelectric power generated at such demonstration projects could be sold.

Section 3. Administration of act. The department may not increase its number of full-time equivalent employees for the purpose of carrying out this act unless the governor finds that adequate contracted services from the private sector are unavailable within the amounts appropriated by this act. The department is authorized to contract for such professional services as are needed to carry out this act.

Section 4. Appropriation. There is appropriated from the interest income of the resource indemnity trust fund or from the renewable resource development clearance fund account, or both, to the department of natural resources and conservation the sum of $350,000 for the purpose of implementing sections 1 through 3.

APPENDIX B

PHYSICAL CHARACTERISTICS OF THE SIX POTENTIAL DEMONSTRATION SITES

A brief description of each of the six project sites studied for potential use as a demonstration project follows. Readers should note that the project features and cost estimates presented in the Lower Deer Creek and Starved to Death Creek descriptions were later revised as a result of subsequent investigations.

PARK-BRANCH CANAL DROP

The Park-Branch Canal Drop project would use an existing canal route located in the segment of the Yellowstone River between Corwin Springs and Livingston. The existing and proposed diversion point is near the town of Emigrant in Park County in Section 4 of Township 6 South, Range 8 East. The approximate elevation of the diversion point is 4,860 feet.

The existing canal, operated by DNRC for the Park-Branch Water Users Association, has a capacity of 350 cubic feet per second (cfs) at the point of diversion. The canal was constructed in 1937 on the west side of the Yellowstone River and is approximately 20 miles long.

As a demonstration project, the existing canal would be enlarged to carry up to 3,000 cfs and extended to a length of 24 miles. Water would be returned to the Yellowstone River at the base of Wineglass Mountain in Section 14, Township 3 South, Range 9 East, at an elevation of 4,580 feet. The drop would require a penstock approximately 1,000 feet in length, with a vertical drop of 260 feet. The penstock would cross U.S. Highway 89 and a track of the Burlington Northern Railroad. Initial water supply investigations indicate that hydropower diversions for this project would average 586,000 acre-feet per year.

The Park-Branch Canal Drop ranked high in the screening process because its construction cost per kilowatt hour was the least among the projects studied at the reconnaissance level. Moreover, the project was assigned a relatively high environmental rating and could be constructed for an estimated cost of $53 million. Existing irrigation systems would continue to be served from the project.

Canyon Mountain Drop

The Canyon Mountain Drop is an alternative to the Park-Branch Canal Drop. If either project were built, the other could not be built; there is not enough water to supply both projects.

The point of diversion for the Canyon Mountain Drop project would be at an elevation of 4,675 feet in Section 11, Township 4 South, Range 9 East, of Park County, near the Pine Creek townsite. The project would be located on the west side of the Yellowstone River. Construction would involve the crossing of two major tributary streams, eight railroad rights of way or county roads, and U.S. Highway 89 twice.

The diversion canal would be 8 miles long and would have a capacity of 3,000 cfs. Water would be returned to the Yellowstone River through a 700-foot-long penstock dropping 100 feet in elevation near the base of Wineglass Mountain. Initial investigations of water supply indicate that hydropower diversions for this project would average 586,000 acre-feet per year.

The Canyon Mountain Drop would have relatively low construction costs per kilowatt hour, and environmental impacts on fish and wildlife resources would be minimal. Moreover, the project would be the least expensive of all potential projects investigated; its initial construction cost is estimated at $27 million. If the project were built, rights of way for the project would have to be acquired from landowners.

Lower Deer Creek

A project on Lower Deer Creek could store 34,000 acre-feet of water at a normal water surface elevation of 4,200 feet. A 39.5-mile-long diversion canal with a capacity of 3,000 cfs would divert water from the Yellowstone River to the project site. The diversion point on the Yellowstone River would be at an elevation of 4,230 feet in Section 28, Township 1 South, Range 12 East, just west of Springdale. The canal route would be located on the south side of the Yellowstone River and would cross six major streams, including the Boulder River. The dam site would be located about 8 miles southeast of Big Timber and 2 miles west of Greycliff.

Hydropower would be produced in two separate operations -- once during the water's 145-foot drop through the dam, and again during a 150-foot drop on its return trip to the Yellowstone River. Water would return to the river through a penstock at the dam, a 12,400-foot-long open channel to the second drop, 2,600 feet of pressurized conduit through the 150-foot drop section, and a short open channel running the remaining distance to the river. Both the 145-foot drop and the 150-foot drop would be equipped with generators. Initial water supply investigations indicate that hydropower releases from the dam would average 622,500 acre-feet per year. Impacts to the Yellowstone River fishery and to wildlife along the canal route and within the reservoir area would be the least of any project investigated.

Valley Creek

The project on Valley Creek would be located approximately 2 miles west of Park City. Water for the project would be diverted from the Yellowstone River at a point in Section 6, Township 2 South, Range 19 East. The proposed diversion point is an existing point of diversion for the Merrill-Columbus Ditch. Elevation at the diversion point would be about 3,680 feet. The diversion canal would be on the north side of the Yellowstone River and would traverse an area north of Columbus.

The proposed canal, with a capacity of 3,000 cfs and a length of 37.5 miles, would supply a reservoir capable of storing 132,000 acre-feet of water at a normal water surface elevation of 3,600 feet. The canal route would require five major stream crossings, five crossings of U.S. Highway 10A, eleven crossings of Interstate 90, and three county road or railroad crossings. These crossings would be a major cost item for the project.

The proposed reservoir would be located in Section 24, Township 2 South, Range 22 East. At its maximum water surface level (approximately 3,300 acres), 4 miles of county road and one homesite would be inundated by the reservoir. Annual hydropower releases would average 582,000 acre-feet, and the hydropower head would be 240 feet. Two hydropower plants--one located at a 40-foot drop in the supply canal just east of Columbus and the other located downstream from the dam--would be included in the project.

Starved to Death Creek

The Starved to Death Creek project would divert water from the Yellowstone River in Section 35, Township 5 North, Range 33 East, near the town of Custer. The elevation of the potential diversion point is 2,725 feet. This point would be approximately 10 miles upstream from the confluence of the Bighorn River with the Yellowstone River.

The Starved to Death Creek project would include a diversion canal with a capacity of 3,000 cfs. This canal, which would traverse the northern side of the Yellowstone River Valley for a distance of approximately 40 miles, would cross major streams twelve times and county roads eleven times.

The Starved to Death Creek dam site would be in Treasure County in Section 26, Township 7 North, Range 37 East. The dam would have a crest length of 2,420 feet and a height of approximately 100 feet. At a normal water surface elevation of 2,700 feet, the reservoir created by the dam would inundate 5,600 acres of land. The reservoir would hold approximately 144,700 acre-feet of water.

The project's single generating station would be adjacent to the Starved to Death Creek dam. A hydraulic head of about 95 feet would produce an estimated 54.8 million kWh of energy per year, based upon annual hydropower releases of 697,000 acre-feet. Hydropower releases from the reservoir site would be returned to the Yellowstone River at an elevation of 2,685 feet in Section 35 of Township 7 North, Range 37 East.

A plan to combine the Froze to Death Creek project with the Starved to Death project was dropped because the Froze to Death Creek project could not produce enough hydropower to make the plan financially attractive.

First Hay Creek

The First Hay Creek project was the only project from Segment 4 of the Yellowstone River Basin selected for further consideration. The project would divert water from the Yellowstone River at an existing diversion point in Section 36 of Township 18 North, Range 56 East in Dawson County. The existing diversion is commonly referred to as "Intake" for the Lower Yellowstone Irrigation Project. Water diverted from the Yellowstone River at this point would be conveyed along the existing canal, which would be enlarged to accommodate 3,250 cfs. The canal would traverse the north side of the Yellowstone River Valley in the vicinity of the communities of Intake, Savage, Crane, Newton Junction, and Sidney. Ten major stream crossings, five highway crossings, and 21 county road or railroad crossings would be required along the canal route.

The 48-mile-long canal would supply water to a storage reservoir located in Township 24 North, Range 59 East. At the normal water surface elevation of 1,955 feet, the reservoir would store 3,300 acre-feet of water and inundate 205 acres. The reservoir would require a dam 42 feet high with a crest length of 2,350 feet. A hydraulic head of 65 feet could be attained if a penstock were extended to the powerhouse, located downstream from the dam. Water would be returned to the Yellowstone River through an open, 3,000-foot-long channel located downstream from the powerhouse.

The estimated construction cost of the First Hay Creek project -- $50.8 million -- is the second lowest of the six projects selected for further investigation. However, the project has one of the lowest ratings for impact on fish and wildlife. The environmental concerns at this site would be primarily related to reductions in Yellowstone River streamflows. Also, improvement of the existing Intake diversion works may adversely affect the spawning runs of Yellowstone River paddlefish.

Excess water exists in the Yellowstone River during all months of the year at the proposed diversion point, with most excess flows available during the fall, winter, and spring months. Diversions of excess water for hydropower during the peak irrigation season (May through September) would be minimal; however, existing and future irrigation water reservations could be met without significantly reducing annual hydropower production at this site. Hydropower production from this project would be consistent during the winter months, which coincides with the period of peak power demand in Montana. Annual hydropower releases over the 65-foot power generating drop would be about 1,337,000 acre-feet.

The project's single [illegible]

assigned to Bear Creek [illegible]

[illegible] ation. The [illegible]

to impact [illegible] than the [illegible] would be primarily related to reductions in Yellowstone River streamflow [illegible] the [illegible] intake diversion [illegible] River [illegible] to make [illegible] more [illegible]

Excess water exists in the Yellowstone River during all months of the year at the proposed diversion point, with most excess flows [illegible] the fall, winter, and spring months. Diversions of excess water for [illegible] the [illegible] capacity 3,250 cfs. The canal would traverse the [illegible] the Yellowstone River valley in the vicinity of the communities of [illegible], Newton [illegible], and Sidney. Ten major stream [illegible] crossings [illegible] county road or railroad crossings [illegible] along the same route.

A [illegible] canal would supply water to a storage reservoir [illegible] in Township 2 North, Range [illegible] East. At the [illegible] water surface elevation of 1,9[illegible] feet, the reservoir would store [illegible],200 acre-feet of water [illegible] acres. The reservoir would require a dam 92 feet [illegible] and a crest length of 2,350 feet. A hydraulic head of 55 feet [illegible] operation, were extended to the powerhouse [illegible] water would be returned to the Ye[illegible] [illegible] channel located [illegible] from

UNIVERSITY OF MONTANA
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